Attorney's File No.: 48 624 X Applicant: Prof. Dr.-Ing. Carl Kramer

Device for Heat Treating Metallic Webs In-line

Patent claims

1. A device for heat treating metallic webs (1) in-line, in a gas atmosphere, in particular for operation with a low-density protective gas, such as for example a nitrogen-hydrogen mixture with a high proportion of hydrogen, characterised by the combination of the following features:

   a) all of the heating (4) and at least the first portion of the cooling (5) is performed in the heat treatment portion, primarily by means of forced convection by blowing said web (1) with impact jets of a heating and/or cooling fluid;
   b) during said heating (4) and at least in the first portion of said cooling (5), the web is guided in a non-contact process;
   c) nozzle fields (8o, 8u, 9o, 9u and/or 8r, 8l, 9r, 9l) for generating said impact jets exert a positionally stabilising effect on the web by deploying a planar force onto the web which, similar to a spring, increases with decreasing distance between the web (1) and the nozzle field, the magnitude of said stabilising force depending on the dynamic pressure of the blowing fluid at the nozzle output of the impact jets;
   d) the distance between the nozzle fields (8, 9), arranged on both sides of the web (1) in the heat treatment portion (4), is substantially constant in each of the respective areas, i.e. heating (4) and cooling (5);
   e) the web (1) is tensed, due to the effect of gravity, in the treatment area (4, 5) localised by rollers (2, 3);
   f) the course of the web between said rollers (2, 3), which localise the treatment area (4, 5), exhibits a concave curvature (as viewed from above), at least in a partial area; and

g) the position of the web is controlled in the area of the trough of the concave curvature (as viewed in the longitudinal section) by at least one sensor (10) which operates in a non-contact manner.

2. The device as set forth in claim 1, characterised in that the rollers (2, 3) which localise the treatment area (4, 5) are at the same height.

3. The device as set forth in claim 1, characterised in that the rollers (2, 3) which localise the treatment area (4, 5) are situated at different heights.

4. The device as set forth in claim 3, characterised in that the rollers (2, 3) are arranged vertically one above the other.

5. The device as set forth in at least one of claims 1 to 4, characterised in that the web (1) is also stabilised perpendicular to the run of the web by the nozzle system for blowing impact jets, said laterally stabilising effect being particularly pronounced in the area of the run of the web having a concave curvature (as viewed from above).

6. The device as set forth in at least one of claims 1 to 5, characterised in that the course of the web having a concave curvature (as viewed from above) in the treatment area is in a fluid (12) which is different from the blowing fluid in the heating portion (4) and in the first portion of the cooling area (5) and which simultaneously demarcates the space (6), which localises the device, with respect to the ambient atmosphere.

7. The device as set forth in claim 6, characterised in that, in the fluid (12) which serves to demarcate the inner space of the device with respect to the outer atmosphere, nozzles (9i, 9a) which stabilise the position of the web are arranged above and below the web and operated using the fluid which serves to demarcate from the outer atmosphere.

8. The device as set forth in any one of claims 6 or 7, characterised in that a suitable liquid, in particular water, is used as said fluid.

9. The device as set forth in at least one of claims 1 to 8, characterised in that the sensor (10) for detecting the position of the web operates in accordance with the principle of echo-location.

10. The device as set forth in at least one of claims 1 to 9, characterised in that the rollers which demarcate the treatment area at the web output are squeezing rollers (11).

11. The device as set forth in at least one of claims 3 to 10, characterised in that, downstream of the turning roller (2) (as viewed in the direction of the run of the web) which demarcates the web treatment area at the web input (7), the web runs vertically and the lower end of the vertical course of the web is followed by a concave web curvature (as viewed from above) which is situated in the fluid shutter (12) which demarcates the treatment space.

12. The device as set forth in any one of claims 3 to 11, characterised in that said fluid shutter comprises a suitable liquid, in particular water.

13. The device as set forth in at least one of claims 3 to 12, characterised in that the web is blown, for the purpose of convectional heat transfer, by means of flow systems (20) which in the longitudinal section (viewed perpendicular to the plane of the web):

a) have the form of a U comprising legs (20 and 24) parallel to the run of the web (1);
b) wherein the leg (24) of the U facing the web is fitted with the stabilising nozzle system (23); and
c) a radial fan (21) is built into the leg (20) of the U facing away from the web; and
d) the flow guide casing is attached to the outer wall with the aid of a crown-shaped component (22); wherein
e) the force is transferred from the tips of the teeth of the crown onto the outer casing and the supporting structure connected to the outer casing.

14. The device as set forth in claim 13, characterised in that, between the legs (20 and 24) of the U-shaped flow guide, jet heating pipes (25) are installed in the heating portion (4) for heating the device, and coolers (28), in particular heat exchangers, for cooling the blowing fluid are situated at this location in the cooling portion (5).

15. The device as set forth in at least one of claims 9 to 14, characterised in that the individual zones of the device are demarcated from each other by intermediate bases made of sheet metal (26) which are formed as trapezium metal sheets.

16. The device as set forth in claim 15, characterised in that said intermediate bases made of trapezium sheet metal (26) for reducing temperature equalisation between adjacent zones is provided on at least one side with layers made of thermal insulation material (27).

17. The device as set forth in at least one of claims 1 to 16, characterised in that the stabilising nozzle system consists of nozzle panes which are consecutive in the direction of the run of the web and comprise nozzle openings made of round holes and/or slit nozzles, whose width – measured parallel to the direction of the run of the web – changes over the width of the nozzle field – measured perpendicular to the direction of the run of the web, and in that the nozzle panes are at least partially bordered at their circumference by slit nozzles.

18. The device as set forth in at least one of claims 1 to 17, characterised in that the gas-tight outer skin (30) on its inner side comprises a wall design which from the outside in is composed as follows:

a) outer layers (32) made primarily of fibres containing silicon dioxide SiO_2;
b) a foil (33) made of a refractory material, in particular a nickel-chromium alloy;
c) layers of fibre mat (34) made of aluminium oxide Al_2O_3;
d) a film (33) made of a highly refractory material, in particular a nickel-chromium alloy;
e) a perforated sheet metal cover (35), consisting of small-format, partially overlapping perforated metal sheets;

wherein the individual layers of said wall design are held by spearing them onto pins (31) attached to the inner wall of the gas-tight outer skin (30), and corresponding attachment platelets (36) are slid onto said pins once the design described above has been put in place.